IML

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April 20, 2019

Data and Model

Fit the model on Boston housing dataset to predict the median values

```
data("Boston", package  = "MASS")
head(Boston)
```

```
##      crim zn indus chas   nox    rm  age    dis rad tax ptratio  black
## 1 0.00632 18  2.31    0 0.538 6.575 65.2 4.0900   1 296    15.3 396.90
## 2 0.02731  0  7.07    0 0.469 6.421 78.9 4.9671   2 242    17.8 396.90
## 3 0.02729  0  7.07    0 0.469 7.185 61.1 4.9671   2 242    17.8 392.83
## 4 0.03237  0  2.18    0 0.458 6.998 45.8 6.0622   3 222    18.7 394.63
## 5 0.06905  0  2.18    0 0.458 7.147 54.2 6.0622   3 222    18.7 396.90
## 6 0.02985  0  2.18    0 0.458 6.430 58.7 6.0622   3 222    18.7 394.12
##   lstat medv
## 1  4.98 24.0
## 2  9.14 21.6
## 3  4.03 34.7
## 4  2.94 33.4
## 5  5.33 36.2
## 6  5.21 28.7
```

```
#install.packages("iml")
#library("randomForest")
library("iml")
library("randomForest")
```

```
## randomForest 4.6-12
```

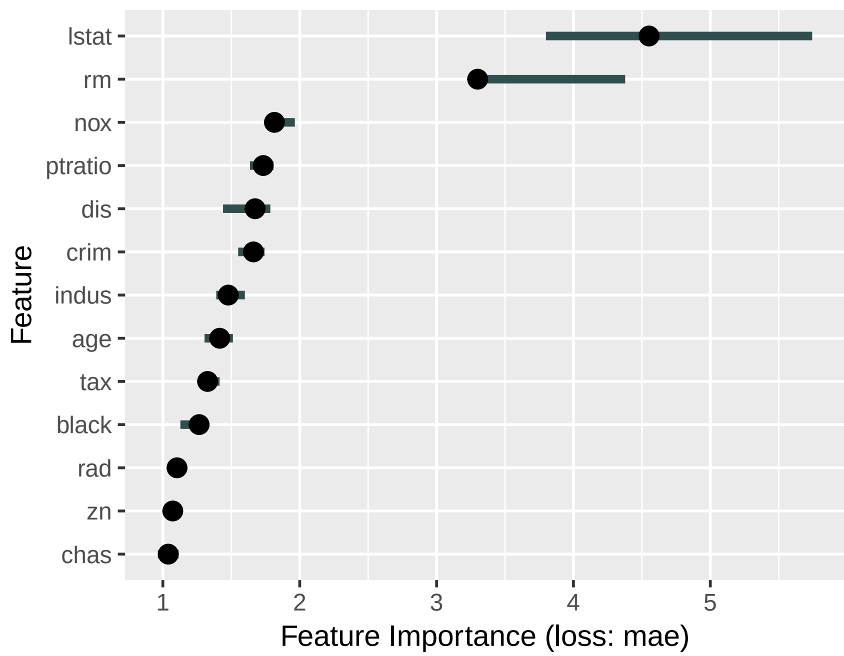
```
## Type rfNews() to see new features/changes/bug fixes.
```

```
set.seed(2019)
rf = randomForest(medv ~ ., data = Boston, ntree = 1000, mtry = 4)
```

```
X = Boston[which(names(Boston) != "medv")]
predictor = Predictor$new(rf, data = X, y = Boston$medv)
```

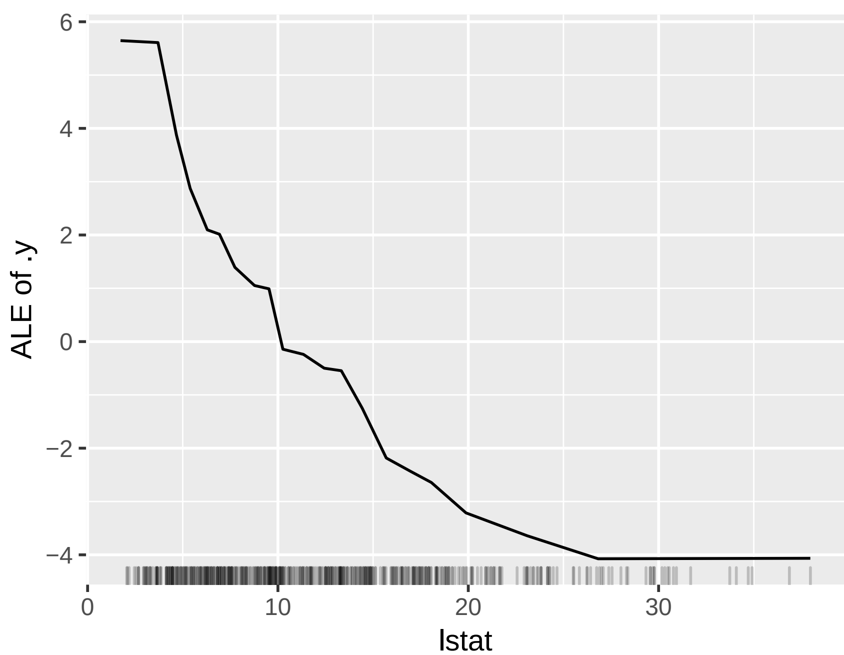
Feature importance obtained by the permutation algorithm

```
imp = FeatureImp$new(predictor, loss = "mae")
plot(imp)
```

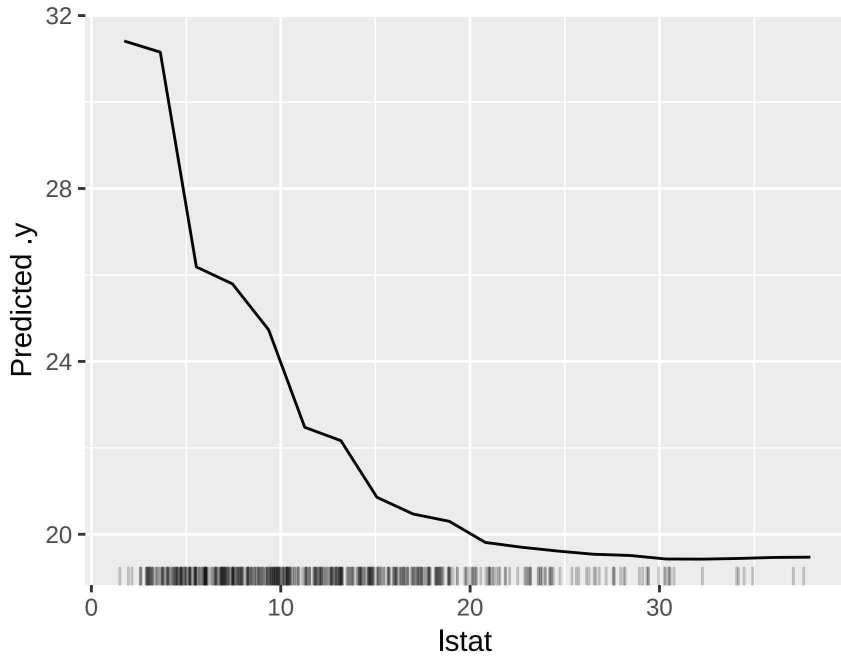


Feature effects (ALE or PDP)

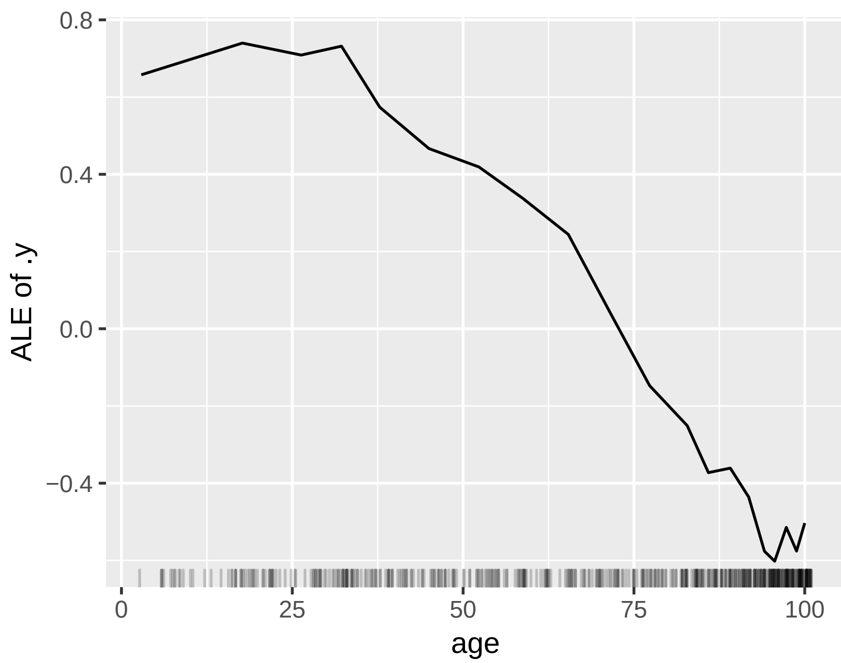
```
ale = FeatureEffect$new(predictor, feature = "lstat",method = "ale",grid.size = 20)
ale$plot()
```



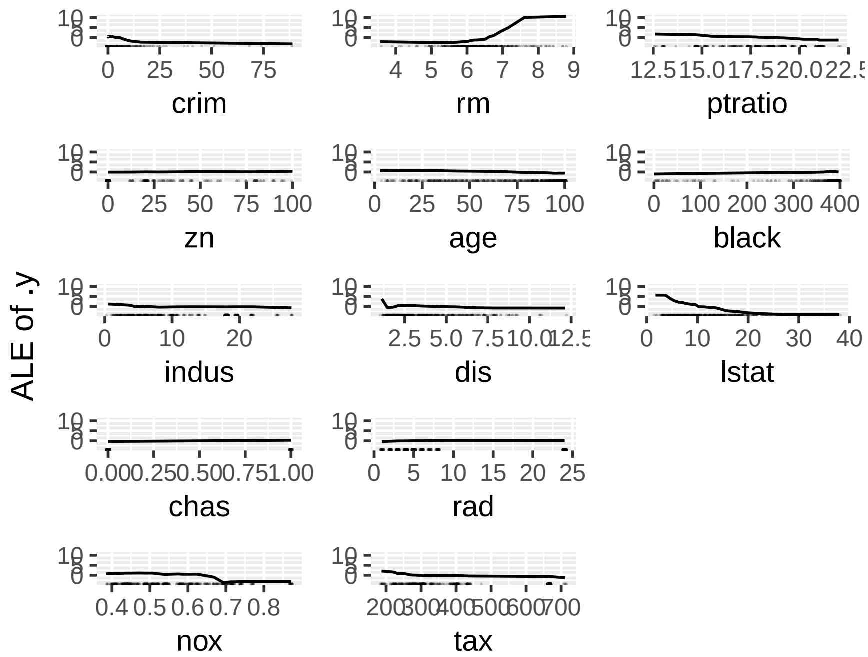

```
pdp = FeatureEffect$new(predictor, feature = "lstat",method = "pdp",grid.size = 20)
pdp$plot()
```




```
ale$set.feature("age")
ale$plot()
```

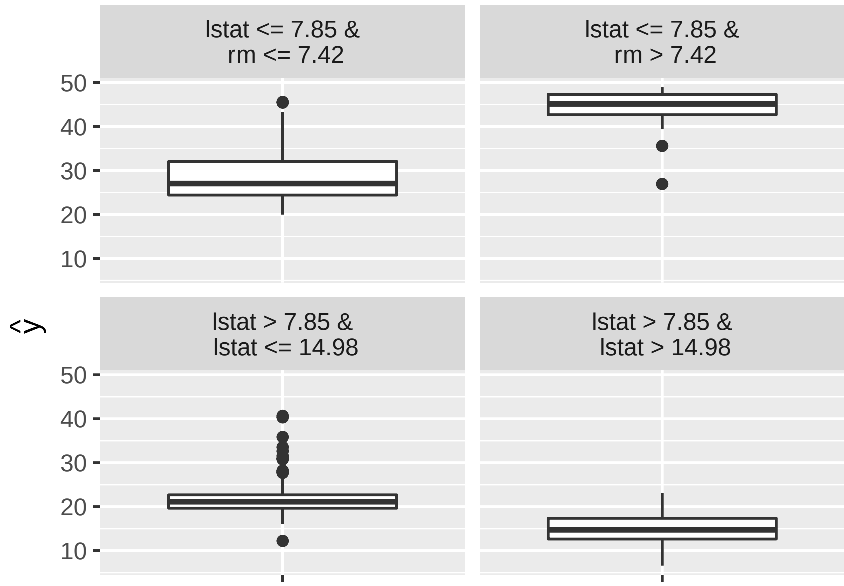



```
effs = FeatureEffects$new(predictor)
plot(effs)
```

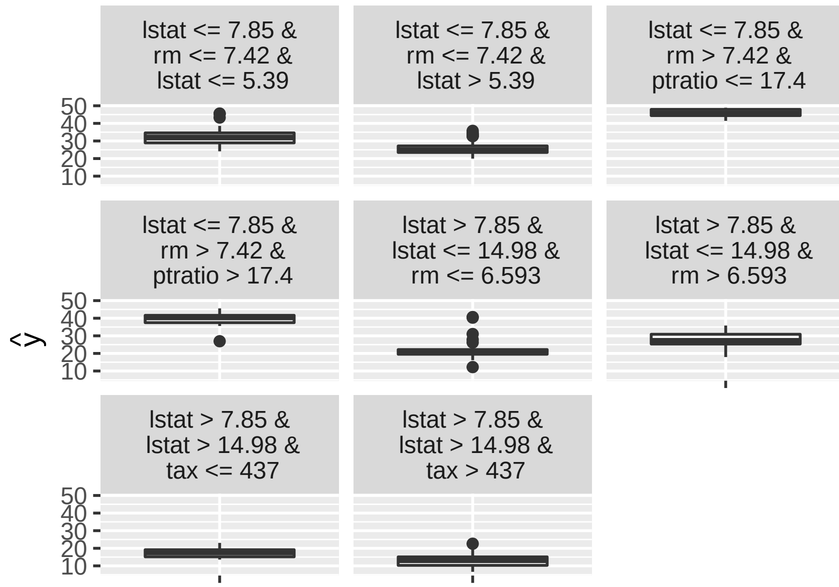


Global Surrogate Model (Tree-based)

```r
tree_sur = TreeSurrogate$new(predictor,maxdepth = 2)
plot(tree_sur)
```




```r
tree_sur = TreeSurrogate$new(predictor,maxdepth = 3)
plot(tree_sur)
```



Local Surrogate Model

LocalModel fits locally weighted linear regression models to explain the indiviual predictions.

```
loc = LocalModel$new(predictor, X[1,], k = 5)
```

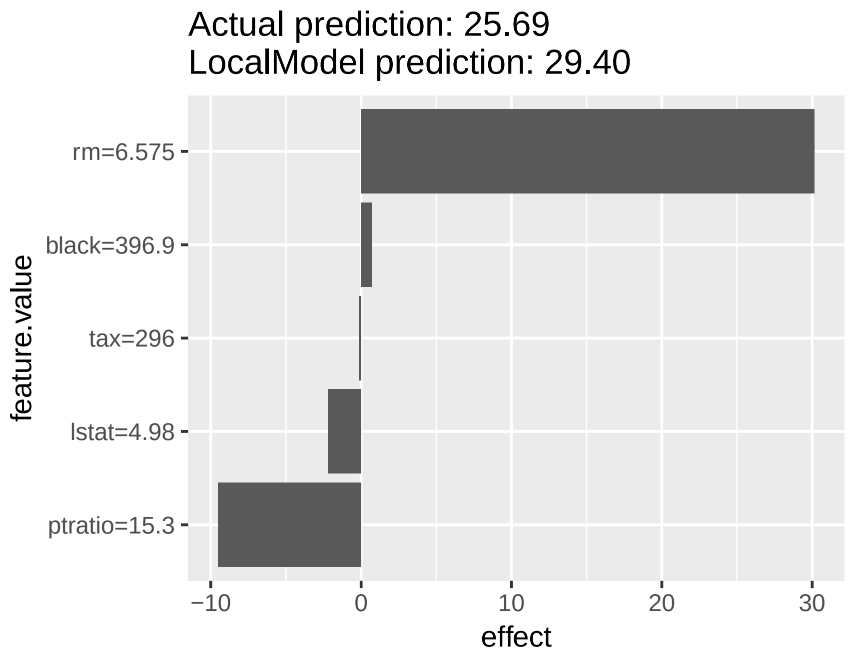
```
## Loading required package: glmnet

## Loading required package: Matrix

## Loading required package: foreach

## Loaded glmnet 2.0-13

## Loading required package: gower
```

```
print(loc)
```

```
## Interpretation method:  LocalModel
##
##
## Analysed predictor:
## Prediction task: unknown
##
##
## Analysed data:
## Sampling from data.frame with 506 rows and 13 columns.
##
## Head of results:
##                 beta x.recoded     effect x.original feature feature.value
## rm        4.58700691     6.575 30.1595704      6.575      rm      rm=6.575
## tax      -0.00049118   296.000 -0.1453893        296     tax       tax=296
## ptratio -0.62226762    15.300 -9.5206946       15.3 ptratio   ptratio=15.3
## black     0.00180294   396.900  0.7155868      396.9   black   black=396.9
```

```
## lstat   -0.44052418     4.980 -2.1938104       4.98    lstat     lstat=4.98
```

```r
plot(loc)
```



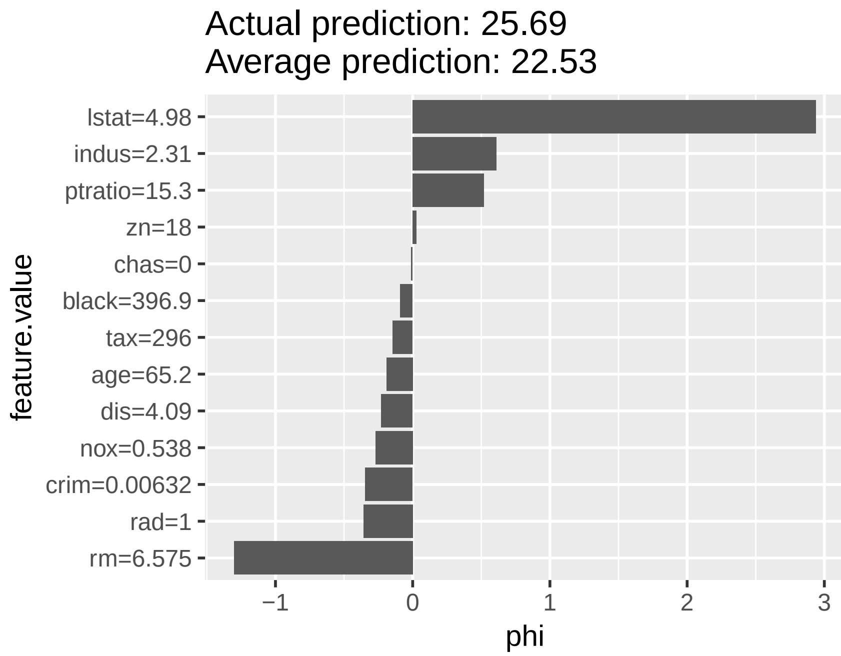
Shapley Value

The contribution of a feature value to the difference between the actual prediction and the mean prediction

```r
shapley = Shapley$new(predictor, X[1,])
print(shapley)
```

```
## Interpretation method:  Shapley
## Predicted value: 25.694383, Average prediction: 22.529530 (diff = 3.164854)
##
## Analysed predictor:
## Prediction task: unknown
##
##
## Analysed data:
## Sampling from data.frame with 506 rows and 13 columns.
##
## Head of results:
##   feature         phi      phi.var feature.value
## 1    crim -0.34601096  0.898376575  crim=0.00632
## 2      zn  0.02567896  0.011977925         zn=18
## 3   indus  0.60867790  0.584654669    indus=2.31
## 4    chas -0.01097749  0.005363373        chas=0
## 5     nox -0.27072254  0.823207605     nox=0.538
## 6      rm -1.30087850 26.643823742      rm=6.575
```

```r
plot(shapley)
```



Actual prediction: 25.69
Average prediction: 22.53
lstat=4.98
indus=2.31
ptratio=15.3
zn=18
chas=0
black=396.9
tax=296
age=65.2
dis=4.09
nox=0.538
crim=0.00632
rad=1
rm=6.575
feature.value
−1
0
1
2
3
phi